arm of one of the men. The cost thus far is $1,188,000. The completed structure weighs 81,000 tons.

In this connection, some of the heights of notable structures may be of interest: Tower of Pisa, 179 feet; Bunker Hill monument, 221 feet; Great mosque, Cairo, 282 feet; Trinity spire, New York, 284 feet; Campanile, Florence, 290 feet; top of capitol, Washington, 307 feet; Milan cathedral, 355 feet; St. Paul's, London, 365 feet; Antwerp cathedral, 402 feet; Lutheran Mariankirche, Lubeck, 430 feet; St. Stephen's, Vienna, 441 feet; St. Rollox chimney, Glasgow, 450 feet; Great pyramid, 450 feet (originally 485 feet); St. Peter's, Rome, 455 feet; Strasbourg cathedral, 468 feet; Cologne cathedral, 511 feet; Philadelphia city hall, to be 535 feet; Washington monument, 555 feet.

Many memorial stones were contributed by the states, and by different organizations in this country, and by foreign countries. Some forty of these stones were set in the interior faces. One hundred still remain in the storehouse, and will probably be affixed as slabs to the interior walls in convenient places.

CHARLES E. GREENE.

THE ELECTRIC LIGHT FOR LIGHT-HOUSES AND SEARCH-LIGHTS.

THE recent experiments in England (*Nature*, vol. xxx. p. 362), upon the relative merits of electric, gas, and oil lights for lighthouse illumination, have called attention to the very marked failure of the arc-light to penetrate through a misty or foggy atmosphere; this failure being due to the vigorous absorption of the blue rays of the spectrum by such an atmosphere, — rays in which the arc-light is especially rich. A very striking case of similar failure was presented to the writer's notice a few evenings ago. One of the streets of Washington has recently been lighted by arc-lights on each side, upon posts several feet higher than the gas-lamps; so that, in looking along the street, the rows of electric lights above the gas offer a good opportunity for comparison. For several nights both were lighted; and one of these nights chanced to be extremely foggy for a few hours in the evening, the ground being covered with slush from melting snow. For this reason I went out of my way to see the effect upon these lights, and was rewarded by the sight of the arc-lights — overpoweringly bright close at hand — becoming almost as faint and yellow as the gas-lamps at a distance of less than half a mile. The extent of the arc-lights was only five blocks, and the treasury building at one end, and patent office at the other, prevented a view from a greater distance; but there can be no doubt, that, if the relative rates of absorption had continued in the same ratio for a greater distance, the arc-lights would have appeared fainter than the gas-lamps at a distance of not much over half a mile, and would have entirely disappeared long before the latter. The arc-lights are said by the company to be of about two thousand candle power, and the gas-lights probably equal between fifteen and twenty candles; so that the enormous difference of absorption under these circumstances is evident at a glance. To be sure, this was a very thick fog; but this is the very condition of things where penetrating power is most necessary for lighthouse lamps, and where the arc-light seems to fail utterly.

For search-lights, in naval warfare, as protection against torpedo attack in thick weather, and for other similar purposes, the case is just as bad, or even worse; for the light must traverse the necessary distance twice, — to the dangerous object, and then reflected back to the ship. For determining the best quality of light for submarine search, experiments upon the selective absorption of sea-water for various kinds of luminous radiant energy would seem to be desirable.

Professor Langley has shown, within the last year or two, that our atmosphere absorbs much more of solar radiant energy than has been heretofore supposed, and that this is very largely in the blue end of the spectrum; so that sunlight, if we were rid of our atmosphere, would be much bluer than we see it. He has shown, too, that this takes place by diffusion of the light by reflection in all directions from particles in the atmosphere, so that we get about half our daylight from the sky, even in a perfectly clear day; and that this is the cause of the blue sky.

The same explanation is sufficient to account for all the phenomena of the wonderful red afterglows following the sunsets of a year ago, if we can explain the presence of reflecting particles in a more or less stratified arrangement (Krakatoa dust, very likely) at an unusual height in the atmosphere. These would reflect sunlight to us in much greater amount and for much longer (semi-intermittent) intervals than the ordinary dust and clouds at a lower level of the atmosphere; and this selective absorption would account for the wonder-

ful color, the light growing redder the farther it traversed the atmosphere.

In a recent article[1] Professor Langley states his belief that much of this diffusion of the blue rays, as also the general absorption of the whole spectrum, is due to fine dust-particles in the atmosphere. The very strong absorption of the blue rays of the arc-light by fog would seem to suggest the inquiry whether the average size of the minute water-drops forming this fog has any thing to do with the remarkably selective effect upon the blue wavelengths, or whether this is simply the absorption effect of water *en masse*.

With the failure of the arc-light to penetrate fog comes the natural inquiry, whether the incandescent lamp will be any better for lighthouse and search-light purposes. Now, the part of the solar spectrum most free from atmospheric absorption-lines is in the orange, with part of the neighboring yellow and red; and some experiments have shown that this region — or the yellow part of it, at any rate — is that in which the incandescent carbon filament is especially rich, relatively more so than the solar spectrum, and it is the brightest part of that. So that there would seem to be every probability that the incandescent lamp would prove very effective in fog penetration, perhaps most efficiently so at a slightly lower temperature and brilliancy than the present average. The difficulty for lighthouse and search-light purposes would be in concentrating a sufficient amount of luminous radiating filaments in a very small space near the focus of a lens or mirror, which is a strong point in the effective use of the arc-light. With single-filament lamps this would be impossible; but the writer can see no insuperable difficulty in arranging a whole bunch or cluster of interlacing loops, joined in multiple arc within the same exhausted globe, so as to present almost a complete network of filaments over a vertical projection of an inch or two square, and yet not have them touch each other; unless, indeed, the great heat might soften the globe enough to let it collapse; and this could probably only be determined by experiment. The suggestion that a slightly lower temperature might be about as effective in fog penetration would help a little, but not very much, on account of the rapid decrease of luminosity, with slight fall in temperature. Special care would need to be taken to make each of the filaments of the cluster of equal resistance with the others; but no more so than in any set of lamps on the same circuit, and no doubt all the difficulties could be speedily surmounted. Some experiments upon the fog-penetrating power of the incandescent lamp would certainly seem to be worthy the attention of those engaged in these matters; for there can be no question about the far greater convenience, cleanliness, safety, and reliability, of the incandescent lamp over all others, even if it is not so economical. But in government lighthouses and war-ships the economy is not so important, reliability and fog-penetrating power being the prime requisites. H. M. PAUL.

[1] *Philosophical magazine*, October, 1884.

RECENT DETERMINATIONS OF LONGITUDE ON THE WEST COAST OF SOUTH AMERICA.

THE recent completion of the longitude measurements on the western coast of South America by the U. S. naval officers, under the command of Lieut.-Commander Charles H. Davis, U.S.N., affords a remarkable proof of the accuracy of the methods and instruments now in use for such operations. Lieut.-Commander Davis commenced his measurement in November, 1883, at Valparaiso, and terminated it in March, 1884, at Panama; connecting there with the chain of measurements made in 1875 by Lieut.-Commander F. M. Green, U.S.N., and measuring from Valparaiso to Arica, Arica to Payta, Payta to Panama,[1] and in December, 1883, with the aid of Dr. B. A. Gould, director of the Cordoba observatory, from Valparaiso to Cordoba. This work completes the telegraphic measurement of the polygon Washington–Key West, Key West–Havana, Havana–Santiago de Cuba, Santiago–Kingston, Kingston–Aspinwall, Aspinwall–Panama,[2] Panama–Payta, Payta–Arica, Arica–Valparaiso, Valparaiso–Cordoba, Cordoba–Buenos Aires, Buenos Aires–Montevideo, Montevideo–Rio de Janeiro, Rio de Janeiro–Bahia, Bahia–Pernambuco, Pernambuco–St. Vincent, St. Vincent–Madeira, Madeira–Lisbon, Lisbon–Greenwich,[3] Greenwich–Washington.[4]

This great chain of longitude measurements, consisting of twenty links, closes with but an insignificant discrepancy; the longitude of the Cordoba observatory by way of Lisbon, Rio de Janeiro, and Buenos Aires, being 4 h. 16 m. 48.06 s., and by way of Wash-

[1] Report of the U. S. coast-survey for 1875, appendix No. 11.
[2] Telegraphic longitudes in the West Indies and Central America, Washington, 1877.
[3] Telegraphic longitudes on the east coast of South America, Washington, 1880.
[4] U. S. coast-survey report for 1870.